REMARKS

Submitted herewith is an Information Disclosure Statement (IDS) setting forth certain prior art not previously considered. Reference to this art was noted after filing an amendment in response to the first office action on this reissue application, and copies of the art were recently obtained. However, because the reference to this art could have been earlier noted, applicant has paid the appropriate fee for late submission of prior art to avoid any later challenge as to whether a fee was due but not paid.

Also, new claims 58 through 65 have been added and various further claim amendments have been made herein, further amending certain claims over the amendments make in response to the first office action. Among these amendments are amendments to claims 22 through 57 specifically adding the buck converter circuitry itself to the claims, so that these claims now claim interleaved DC to DC buck converters, rather than a circuit for controlling interleaved DC to DC converters.

In review of the prior art submitted herewith, and without diverting the Examiner's attention from the other prior art submitted, the undersigned would like to direct the Examiner's attention to the article entitled "A 600 Watt Four Stage Phase-Shifted-Parallel DC-to-DC Converter" submitted with the present IDS, which for convenience, I will call "Reference 1" herein.

That article referred to a reference "[6]", which is the article entitled "Investigations of Stability and Dynamic Performances of Switching Regulators Employing Current-Injected Control," a copy of which is also submitted with the present IDS. I will refer to that article herein as "Reference 2."

The paragraph in Reference 1 near the bottom of the left column of page 138, which paragraph relates to flyback (buck-boost) converters, states:

> "While the PSP concept is not new, the architecture developed here of four flyback converters is new. This concept is illustrated in Figure 5. Each stage is essentially a power converter operating in a constant frequency mode. The currents in each stage are ensured of being balanced, because the current injected control as described in [6] is used. Four stages are used in phase-shifted-parallel. The converter architecture for each stage was chosen to be the buck-boost or flyback."

Figure 6 at the top of the right column on the same page shows the four stages referred to in the above quote. That Figure indicates that while the operation of the stages is interleaved, there is no connection between stages indicative of any signal altering the operation of one stage based on the relative currents in the various stages.

Reference 2 is concerned with single stage buck-boost switching regulators "employing current-injected control." Figure 1 (page 3) shows a circuit schematic of a current-injected control buck/boost regulator. The "small-signal analytical processor equivalent" is shown on Figure 4 (page 6), and is consistent with the relevant portion of Figure 1. The next to the last paragraph in the right column of page 6 states:

> "The second loop is the ac sensing loop which serves two functions. The first function is to transform the primary switch-current into a proportional voltage signal. The voltage signal, v_{SW}, is then compared with v_X resulting in a control mechanism that turns off the power switch when $v_{SW} = v_X$. The second function of the ac loop is to drive the low-frequency modulation signal or error signal for additional loop compensation."

Considering Figure 4 of Reference 2, the feedback of the voltage on node A (a voltage proportional to the output voltage V_O) is through an integrator. Consequently, assuming stability of the loop for a single stage buck-boost converter, the output of the integrator will settle when the voltage at node A equals the reference voltage into the integrator, and the switch current is proper to maintain the output voltage V_O at the intended regulated level.

However, in a multiple stage buck-boost converter, assume one buck-boost converter is taking a larger than average share of the load current and another is carrying a smaller share. At regulation, the voltage at node A will equal the reference voltage applied to the integrators of both buck-boost converters. However the output of the integrators can settle at different voltages, specifically at voltages that support the difference in the load currents of the buck-boost regulators.

Consequently, neither reference, nor the two references combined, provide any disclosure supporting the statement in Reference 1 that "The currents in each stage are ensured of being balanced, because the current injected control as described in [6] is used." To the contrary, imbalances can accumulate, not only because of the integrating effect of the transformers, but also because of the integrating effect of the integrator in the AC feedback loop of reference 2. Further, these references relate to buck-boost converters, namely converters that use a transformer to couple to the load, whereas claims 22, 24-31 and 33-65 relate to simple buck converters that use an inductor that is alternately coupled between a power supply and ground, and ground and the common load, whether using transistors as the high side and low side devices as in the preferred embodiment of the present invention, or using a diode as the low side rectifying device as in other alternate common buck converters. Finally,

none of the art discloses or render obvious the integration of the interleaved controllers in a single integrated circuit.

Therefore, this art neither discloses nor renders obvious the present invention because:

1. The foregoing references relate to buck-boost converters, not simple buck converters (claims 22, 24-31 and 33-65).

2. The foregoing references do not teach or suggest the integration of the interleaved controller components in a single integrated circuit (claims 1-22, 24-31, 33-46, 51-53 and 58-65).

3. The foregoing references do not disclose or render obvious current balancing, at least in the context that current balancing is used in the present application and claims under consideration (claims 1-22, 24-32 and 34-57).

4. The foregoing references do not disclose or render obvious certain claim limitations in the independent claims under consideration that define how current balancing is accomplished (claims 1-22, 24-32 and 34-57). Specifically, the references fail to disclose or render obvious the following:

Claim 1. "the control circuits also being responsive to the difference in the voltage across the sense resistor when the first converter is drawing power

from the power supply through the sense resistor and the second converter is not, and when the second converter is drawing power from the power supply through the sense resistor and the first converter is not, to adjust the relative duty cycle of the first and second converters to tend to minimize the difference in the voltage across the sense resistor;"

Claim 10. "the control circuits also being responsive to the difference in current through the first converter and the second converter to adjust the relative duty cycle of the first and second converters to tend to minimize the difference in the voltage across a sense resistor;"

Claim 22. "a current balance control circuit responsive to the difference in current in the plurality of interleaved buck converter circuits and controlling the pulse width modulators to balance the current in the plurality of interleaved buck converter circuits;"

Claim 32. "control circuits responsive to the feedback circuit and a commanded output voltage to control a nominal duty cycle of the plurality of buck converter circuits, the control circuits also

being responsive to the difference in current in the plurality of interleaved buck converter circuits to adjust a relative duty cycle of the plurality of buck converter circuits to balance the current in the buck converter circuits;"

Claim 45. "control circuits for adjusting a nominal duty cycle of the plurality of interleaved buck converter circuits, the control circuits also being responsive to the difference in current in the plurality of interleaved buck converter circuits to adjust the relative duty cycle of the plurality of buck converter circuits to balance the current therein;"

Claim 46. "the control circuits also being responsive to current measurements in the first buck converter circuit and the second buck converter circuit for adjusting the relative duty cycle of the first and second pulse width modulators to balance the currents in the buck converter circuits;"

Claim 47. "a current balance control circuit responsive to the difference in current in the plurality of interleaved buck converter circuits for controlling the pulse width modulators to balance

the current in the plurality of interleaved buck converter circuits."

Claim 48. "control circuits responsive to the feedback circuit and a commanded output voltage to control a nominal duty cycle of the plurality of buck converter circuits, the control circuits also being responsive to the difference in current in the plurality of interleaved buck converter circuits to adjust the relative duty cycle of the plurality of buck converter circuits to balance the current in the buck converter circuits."

Claim 49. "control circuits . . . for responding to the difference in current in the plurality of interleaved buck converter circuits to adjust the relative duty cycle of the plurality of buck converter circuits to balance the current in the buck converter circuits."

Claim 50. "the control circuits also being responsive to current measurements through the first buck converter circuit and the second buck converter circuit to adjust the relative duty cycle of the first and second buck converter circuits."

Claim 51. "a current balance control circuit for controlling the pulse width modulators responsive to a difference in current in the inductors of the plurality of interleaved buck converter circuits to balance the current in the plurality of interleaved buck converter circuits;"

Claim 52. "control circuits being responsive to the feedback circuit and a commanded output voltage to control a nominal duty cycle of the plurality of buck converter circuits, the control circuits also being responsive to the difference in currents in the plurality of interleaved buck converter circuits to adjust the relative duty cycle of the plurality of buck converter circuits to balance the current in the buck converter circuits;"

Claim 53. "the control circuits also being responsive to current measurements in the first buck converter circuit and the second buck converter circuit to adjust the relative duty cycle of the first and second buck converter circuits;"

Claim 54. "a current balance control circuit for controlling the pulse width modulators to balance the current in the plurality of interleaved buck converter circuits responsive to the difference in current

in the plurality of interleaved buck converter circuits."

Claim 55. "control circuits responsive to the feedback circuit and a commanded output voltage to control a nominal duty cycle of the plurality of buck converter circuits, the control circuits also adjusting a relative duty cycle of the plurality of buck converter circuits to balance the current in the buck converter circuits responsive to the difference in current in the plurality of interleaved buck converter circuits."

Claim 56. "control circuits . . . for adjusting a relative duty cycle of the plurality of buck converter circuits to balance the current in the buck converter circuits."

Claim 57. "the control circuits also being responsive to current measurements in the first buck converter circuit and the second buck converter circuit to adjust the relative duty cycle of the first and second buck converter circuits."

In addition, Applicant would like to bring the Examiner's attention to certain facts in accordance with Rule 1.56 of the Rules of Practice in Patent Cases. In particular, Applicant's

Attorney noted a copyright notice on three, 2 page Linear Technology product data sheets for part numbers LTC1629, LTC1709-8/LTC1709-9 and LTC1929, attached hereto as Exhibits A, B and C respectively. Each of these documents is a printout taken quite some time ago (date uncertain) from the Linear Technology website, and has a Copyright notice of 1996,97.

Applicant has reviewed the Linear Technology databooks for 1996 and 1997 and found no mention of any of the foregoing parts or datasheets. The earliest reference Applicant found to Linear Technology multiphase converters is September 1999, located in a search of Linear Technology's application notes database on their Website. The undersigned has printed out that 2 page application note directly from the Internet, a copy of which is attached as Exhibit D. Note that while the application note as printed directly from the Internet is cut off on the right side, a 2000 Copyright notice appears at the end of the second page. The application note was also downloaded in PDF format and printed out, a copy of which is attached as Exhibit E. This is a 16 page application note, and has a September 1999 notation at the upper right of the first page, and a 1999 copyright notice at the bottom of the last page.

A search of the EDN (Electronic Design News) archive database showed that the first time there was a published article

on dual (or multiphase) phase converters where these LTC products are mentioned is dated 11/11/99.

Finally, a 2 page data sheet for the LTC1629 was printed directly from the Internet, and a 28 page data sheet for the same part was downloaded as a PDF file and printed out. Copies of these documents are attached as Exhibit F and G, respectively. Note that the 2 page data sheet (cut off on the right side) printed directly from the Internet has a 2000 Copyright notice at the end of it, while the 28 page data sheet has a 1999 copyright notice at the bottom of the last page.

It definitely appears that the 1996,97 copyright notices at the end of the 2 page documents of Exhibits A, B and C, as with the other 2 page documents printed directly from the Website, are copyright notices for the Website, not for the publications or information on the Website. This conclusion is bolstered by the fact that products known to Applicant to be first introduced in 2001 show a copyright notice at the end of the Website versions of 2000.

Consequently, Applicant has concluded that to its best knowledge, the available evidence of LTC first publicizing a multiphase converter is dated no earlier than September 1999, and therefore such parts and information thereon are not prior art for the present application.

Accordingly, it is believed that all claims in the case are now in condition for allowance and therefore allowance at an early date is respectfully requested.